

COMPARATIVE FEEDING BEHAVIOR OF TWO APHID SPECIES:
BEAN APHID (*APHIS FABAE* SCOPOLI) AND PEA APHID
(*ACYRTHOSIPHON PISUM* (HARRIS))
(HOMOPTERA: APHIDIDAE)

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Abstract.—A comparative feeding site preference and competition study was performed in the laboratory on two species of aphids, the bean aphid, *Aphis fabae* Scopoli, and the pea aphid, *Acyrtosiphon pisum* (Harris). The two species were raised separately and together on broad bean, *Vicia faba*. When raised separately, *A. fabae* was found about equally on leaves and stems, and preferred leaf undersides to leaf uppersides by a 2:1 ratio. *A. pisum*, however, strongly preferred leaves to stems, and leaf undersides to leaf uppersides, both by more than 90%. But, when raised together, *A. fabae* developed a noticeable change in preferences, preferring leaves by 83% and leaf undersides by 90%. No major change was seen in preferences of *A. pisum*.

Introduction

The preferences in feeding sites of aphids have long been of interest to a wide variety of entomologists. Feeding site preferences have implications for the type of damage done to plants, the ease with which chemical and biological controls can affect the aphids, the accuracy of standard sampling methods, and the breeding of resistant plant varieties.

Leaf age.—Preferences in leaf age were studied by Kennedy et al. (1950) and Kennedy and Ibbotson (1950). They found that *Myzus persicae* (Sulzer) and *Aphis fabae* Scopoli preferred young or early senescent leaves, while avoiding mature leaves on the sugar beet and spindle tree. Similar results were obtained by Wearing (1972) for *M. persicae* and *Brevicoryne brassicae* (Linnaeus) on brussel sprouts. This preference, however, was stronger in *M. persicae*. Kennedy and Booth (1951) later found that the reproductive rate was also similarly affected by leaf age. Preference in *M. persicae* for older leaves on potatoes was found by Taylor (1955), but he failed to find any difference in *Aphis nasturtii* Kalténbach. Differences between the two races of *M. persicae* were reported by Tanaka (1957), who found the green

race preferring younger leaves to a greater extent than the pink race, which preferred the older.

Position on plant.—Preferences in position on the whole plant have also been studied. Shands et al. (1954) studied 3 aphid species on potatoes: *Myzus persicae*, *Macrosiphum solanifolii* (Ashmead), and *Aphis abbreviata* (Patch). *M. solanifolii* had the highest percentage on the top leaves of the 3 species studied. Even on the same leaf, *A. abbreviata* and *M. persicae* had preferences for different leaflets. Doucette (1961), while studying 3 other species, found that *Macrosiphum scoliopi* (Essig) preferred undersides of lower leaves of Easter lily, while *Aphis gossypii* Glover preferred edges of undersides of top leaves. *Myzus solani* (Kaltenbach) preferred young leaves and buds near the tip.

Leaf uppersides or undersides.—Whether uppersides or undersides of leaves are chosen by aphids has also been the subject of some study. With the aphid, *Eucallipterus tiliae* (Linnaeus), feeding on lime (*Tilia* spp.), Kidd (1976) found that both uppersides and undersides were colonized in the laboratory, while only undersides were colonized in the field. Dixon and Logan (1973) reported an underside preference in *Drepanosiphum platanoideis* (Schrank). Cruz and Bernardo (1971) found a similar behavior for *Aphis gossypii*. Contrasting these studies, Wyatt (1965) noted that a majority of aphids on the terminal buds of chrysanthemum were on the upper surface, although this preference was reversed on the lower leaves. Uppersides were also preferred by *Hyalopterus prunii* (Geoffroy) on peach and plum in a study by El-Kady (1971). Four aphids on potatoes prefer undersides: *Macrosiphum euphorbiae* Thomas, *Myzus persicae*, *Aphis nasturtii*, and *Aulacorthum solani* (Kaltenbach) (Gibson 1972).

Bean aphid and pea aphid.—In direct relation to this present research, *Aphis fabae* Scopoli, the bean aphid, and *Acyrtosiphon pisum* (Harris), the pea aphid, have been the subjects of a number of studies on feeding as well.

1) Leaves vs. stem: Bond and Lowe (1975) found resistant varieties of *V. faba* to be colonized by *A. fabae* approximately 50% on the leaf and 50% on the stem, while susceptible varieties were more heavily colonized on the leaves. Lowe and Taylor (1964) found that both green and red races of *A. pisum* preferred leaves to stems of *V. faba*, with from 86% to 98% of the green preferring leaves, and from 91% to 98% of the red preferring leaves. Lowe (1967), studying only those *A. fabae* that settled on leaf undersides, found that they fed only on veins, ignoring lamina and margins. *A. pisum*, on undersides, were found to be on veins 93.3% of the time. On the same plant at the same time, Tambs-Lyche and Kennedy (1958) found that *A. pisum* was more numerous on the leaves than *A. fabae*.

2) Leaf uppersides or undersides: In reference to the uppersides or undersides of leaves, Dixon and Wratten (1971) reported that *A. fabae* feeds

on either surface of *V. faba*. However, this was not true in the research by Hull (1964) who found only underside feeding on the sweet pea. *A. pisum* was also an underside feeder, ranging from 93% to 98% on leaf undersides. It should be noted, however, that a different host plant was used in the study. *A. pisum* on *V. faba* was found to be primarily an underside feeder by Muller et al. (1974).

In this present research, two types of positional preferences were studied in the laboratory: leaf or stem preference, and upperside or underside preference, using both the bean aphid, *Aphis fabae*, and the pea aphid, *Acyrtosiphon pisum*. These preferences were measured in the aphids as they colonized broad bean, *Vicia faba*, separately, and as they colonized it together. Preferences and changes in preferences between the two species raised separately and then raised together were recorded.

3) Aggregation: Aggregation has been found in both species. Kennedy and Ibbotson (1951) found aggregation in *A. fabae* on spindle trees and sugar beets, while Strong (1967) found aggregation in 1st and 2nd instar nymphs of *A. pisum*. The results of the present research will be related to these studies of aggregation.

Materials and Methods

Two species of aphids were used in this study: the bean aphid, *Aphis fabae* Scopoli, and the pea aphid, *Acyrtosiphon pisum* (Harris). The broad bean, *Vicia faba* Linnaeus (Windsor variety), served as the host plant for both aphids. Seeds were obtained from the W. Atlee Burpee Co., and germinated in a mixture of Baccto potting soil and vermiculite in a ratio of 2:1. Prior to planting, the seeds were dusted with a powdered fungicide, Orthocide, to inhibit the growth of fungi.

Two rows of 4 seeds each were planted in plastic trays and placed in a dark cabinet for approximately 5 days to ensure germination. When the seeds had sprouted, they were transferred to an insect cage illuminated with continuous light by 1 Sylvania Gro-Lux 40 W bulb and 1 Westinghouse 40 W cool white fluorescent bulb. Temperature in the cage varied between 18° and 25°C.

For the first 8 weeks of the experiment, 2 trays were selected and 6 sprouts were left in each tray through the removal of any stunted or incompletely sprouted seeds. One apterous aphid was placed on each of these 6 sprouts, using a camel's hair brush. Sprouts selected for the aphids were approximately 5 cm in height. The gravid females were selected from stock cultures of aphids reared on broad bean. One tray of broad bean sprouts, therefore, had 6 gravid bean aphids, one to a plant, and the other tray 6 gravid pea aphids, one to a plant. These were placed in separate insect cages.

Counts were taken on the 2nd, 5th and 7th days. Aphids were counted and recorded in 3 categories: aphids on stems, on leaf uppersides, and on leaf undersides. At the end of the 7th day count, the tray was discarded and a new tray begun.

During the final 4 weeks of the experiment, the procedure was similar except for the addition of a third tray of 6 sprouts. On each sprout of this tray, one gravid bean aphid and one gravid pea aphid were placed. This tray was placed in a third separate continuous light insect cage, and similar counts were made on the 2nd, 5th and 7th days.

Results and Discussion

1) *Reared separately: leaves vs. stem.*—a) The bean aphid reared by itself showed no preference in feeding site, being evenly divided between leaves (49.4%) and stems (50.6%). These results were very similar to those of Bond and Lowe (1975) who reported a division of 50% leaf to 50% stem.

b) Pea aphids reared by themselves were much more particular, with 95.0% preferring leaves to stems. This was parallel to the results of Lowe and Taylor (1964), who found that the green race of the pea aphid preferred leaves by a percentage varying from 86% to 98%. Tambs-Lyche and Kennedy (1958) also reported that the pea aphid preferred leaves to a greater extent than did the bean aphid when the two were raised separately.

2) *Reared separately: leaf uppersides or undersides.*—a) Those bean aphids found on the leaf preferred the underside of the leaf (64.5%) to the upperside (35.5%) by a 2:1 ratio. Dixon and Wratten (1971) noted feeding on both the uppersides and undersides of leaves of *Vicia faba* by the bean aphid, but did not quantify these observations. Hull (1964) found only underside leaf feeding in the bean aphid on sweet pea, but these results may not be directly comparable due to the different host plants.

b) Pea aphids were again more particular, with 93.4% of them preferring the underside. This is also similar to the results of Hull (1964), who found the pea aphid preferring leaf undersides on sweet pea from 93% to 98%. Muller et al. (1974) also found the pea aphid to be primarily a leaf underside feeder on *Vicia faba*.

3) *Reared together: leaves vs. stem.*—No previous studies have measured differences or changes in feeding site preferences between these two species when reared together as compared to their behavior when reared separately. In the present study, the 2 species raised together showed some dramatic behavioral changes for the bean aphid, but little change for the pea aphid.

a) Bean aphids reared together with pea aphids developed a much stronger preference for leaves rather than stems: 83.1% compared to the original 49.4% ($P < .0001$, Chi square test).

b) Pea aphids reared together with bean aphids showed no noticeable

Table 1. Results of experiment on feeding site preferences.

	Leaf		Stem	
	No.	%	No.	%
1) Reared separately				
Bean aphid	677	49.4	693	50.6
Pea aphid	3,104	95.0	165	5.0
	Leaf upperside		Leaf underside	
	No.	%	No.	%
Bean aphid	240	35.5	437	64.5
Pea aphid	205	6.6	2,899	93.4
	Leaf		Stem	
	No.	%	No.	%
2) Reared together				
Bean aphid	723	83.1	147	16.9
Pea aphid	1,250	94.3	75	5.7
	Leaf upperside		Leaf underside	
	No.	%	No.	%
Bean aphid	70	9.7	653	90.3
Pea aphid	106	8.5	1,144	91.5

change in behavior, preferring leaves by almost the same percentage (94.3%) as when reared alone.

4) *Reared together: leaf uppersides or undersides.*—a) When reared together with the pea aphid, the bean aphids on the leaves also developed a much stronger preference for leaf undersides (90.3%) ($P < .001$).

b) The pea aphid preference changed only slightly, with 91.5% preferring undersides, compared to 93.4% when reared separately. This change, although small, was statistically significant ($P < .01$).

The results of both parts of the study are presented in Table 1. In summary, the presence of the pea aphid seemed to cause the bean aphid to move from stems to leaves and from leaf uppersides to leaf undersides. No major change was seen in the pea aphid preferences.

Intraspecific aggregation: A possible explanation of these results might involve the phenomenon of aggregation. Individuals in many aphid species have been shown to have a strong preference for locations on the host plant in close proximity to groups of other aphids of the same species. This intraspecific aggregation behavior is independent of the quality of the feeding site. That is to say, given apparently equal feeding sites, aphids often choose one near another aphid or group of aphids. Kennedy and Ibbotson (1951) found such aggregation in the bean aphid on spindle trees and sugar beets,

and it is said to be well known in other cases (Heathcote 1972). Aggregation has also been reported in the pea aphid by Strong (1967) who found it in 1st and 2nd instar nymphs.

Interspecific aggregation: It is conceivable that an interspecific aggregation has occurred in this research. The pea aphid showed an unchanging but strong preference for leaves and leaf undersides throughout the study, regardless of the presence or absence of the bean aphid. The bean aphid, however, which was found to a great degree on both stems and leaf upper-sides when reared separately, strongly preferred leaf undersides when raised with the pea aphid. This appears to be a form of interspecific aggregation or an enhancement of the bean aphid's tendency to aggregate, and may be to the bean aphid's advantage in some way, possibly for protection. This apparent aggregation was surprising in that an expected result of such a combination of two species might have been a form of niche splitting. It would have been thought that increased competition for feeding sites might have logically led to the bean aphid's leaving the leaf undersides to the pea aphid and concentrating on stems and leaf upper-sides for feeding sites, where interspecific competition would be minimal. Surprisingly, the opposite occurred. Aggregation for protection or some other advantage is the suggested partial answer.

Other possible factors which could affect the feeding site preferences of these aphids that were not studied here include the relative nutritional quality of the stems, leaf upper-sides and leaf undersides, and the age of the plant when first colonized by the aphids. These two factors of nutrition and age will be explored in future work.

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Received for publication October 14, 1981.